

CLAIMS

1. A waterproof breathable sole for shoes, comprising, for at least part of its extension, at least two structural layers, a lower one (14) provided with a supporting structure so as to form the tread, and an upper microporous one (15, 215) that is permeable to water vapor, said lower layer (14) having portions (14a, 114a) that are open onto said upper layer (15, 215), said sole being characterized in that at least one of the two surfaces (15a, 15b) of said upper layer (15, 215) has a coating (21, 221) obtained by means of a plasma deposition treatment for waterproofing.
- 10 2. The sole according to claim 1, characterized in that said coating (21, 221) is provided on the upper surface (15b) of said upper layer (15, 215).
- 15 3. The sole according to claim 1, characterized in that said coating (21, 221) is provided on the lower surface (15a, 215a) of said upper layer (15, 215).
4. The sole according to claim 1, characterized in that said coating (21, 221) is provided both on the lower surface (15a, 215a) and on the upper surface (15b) of said upper layer (15, 215).
- 20 5. The sole according to one of the preceding claims, characterized in that said upper layer (15, 215) and said lower layer (14) are joined hermetically along their perimeter in order to avoid water infiltrations.
6. The sole according to one of the preceding claims, characterized in that said upper layer (15, 215) is made of sintered plastic material.
- 25 7. The sole according to claim 6, characterized in that said sintered plastic material is polyethylene, polypropylene, polystyrene or polyester.
8. The sole according to claim 1, characterized in that said upper layer (15, 215) is selected among any of a felt, a fleece, a fabric or mesh made of synthetic material.
- 30 9. The sole according to claim 1, characterized in that said upper layer (15, 215) has an average pore width comprised between 3 and 250 µm.

10. The sole according to claim 1, characterized in that said upper layer (15, 215) is rendered hydrophobic.

11. The sole according to one of the preceding claims, characterized in that said lower layer (14) is constituted by a perimetric skirt (16) that
5 constitutes the outer edge of said sole (10), and by ground contact elements (17), which are designed to support said upper layer (15, 215), the spaces of said lower layer (14) comprised between each one of said ground contact elements (17), and between said ground contact elements (17) and said skirt (16), forming said portions (14a, 114a).

10 12. The sole according to one of the preceding claims, characterized in that said plasma deposition treatment is obtained by working in high-vacuum cold plasma conditions.

13. The sole according to one of the preceding claims, characterized in that said plasma deposition treatment is obtained by using a
15 radiofrequency generator so that the electrical field in the treatment oscillates with a frequency substantially comprised between 13 MHz and 14 MHz.

14. The sole according to one of the preceding claims, characterized in that said plasma deposition treatment is obtained by using a
20 radiofrequency generator so that the electrical field in the treatment oscillates with a frequency preferably on the order of 13.56 MHz.

15. The sole according to one of the preceding claims, characterized in that said plasma deposition treatment is obtained by using a power of the
applied electrical field in the treatment that is substantially comprised
25 between 50 and 700 W.

16. The sole according to one of the preceding claims, characterized in that the duration of said plasma deposition treatment for a siloxane-based monomer is comprised between 160 seconds and 600 seconds.

17. The sole according to claim 16, characterized in that the duration
30 of said plasma deposition treatment for a siloxane-based monomer is

substantially equal to 420 seconds.

18. The sole according to one of the preceding claims, characterized in that the vacuum level in said plasma deposition treatment is substantially comprised between 10^{-1} mbar and 10^{-5} mbar.

5 19. The sole according to one of claims 1 to 11, characterized in that said plasma deposition treatment is obtained by working in high-vacuum cold plasma conditions and by using a radiofrequency generator so that the electrical field in the treatment oscillates with a frequency on the order of 13.56 MHz, with an applied electrical field power equal to 50-700 W and a
10 vacuum level comprised between 10^{-1} mbar and 10^{-5} mbar.

20. The sole according to one of the preceding claims, characterized in that the precursor material of the plasma deposition is a siloxane-based monomer.

15 21. The sole according to one of the preceding claims, characterized in that the precursor material of the plasma deposition is an oil-repellent and water-repellent fluoropolymer.

22. The sole according to claim 1, characterized in that the material of said coating (21, 221) is a polysiloxane.

20 23. The sole according to claim 1, characterized in that the material of said coating (21, 221) is an oil-repellent and water-repellent fluoropolymer.

24. The sole according to claim 23, characterized in that said fluoropolymer is commercially known by the trade name Zonyl® and is manufactured by DuPont.

25 25. A breathable and waterproof sole for shoes, comprising, for at least part of its extension, at least two structural layers (314, 315), a lower one (314) with a supporting structure so as to form the tread and an upper microporous one (315) that is permeable to water vapor, a waterproof membrane (321) being provided above said upper layer (315), said lower layer (314) being provided with portions (314a) that are open onto said upper layer (315), said sole (300) being characterized in that said upper

layer (315) and said waterproof membrane (321) are hermetically joined along their perimeter so as to avoid water infiltrations.

26. A waterproof and breathable shoe, characterized in that it comprises a sole according to one of the preceding claims.

5 27. A waterproof and breathable shoe, characterized in that it comprises the following combination of elements:

- an assembly (401, 501), which surrounds in a pouch-like manner the foot insertion region and comprises a breathable upper (412, 512) with which a waterproof membrane (421, 521) is associated at least in a downward region,
- a sole (400, 500), which is associated below said assembly (401, 501) and comprises, along at least part of its extension, at least two structural layers (414, 514, 415, 515), a lower one (414, 514) having a supporting structure so as to form the tread, the upper one (415, 515) being microporous and permeable to water vapor, said lower layer (414, 514) having portions (414a, 514a) that are open onto said upper layer (415, 515).

15 28. The shoe according to claim 27, characterized in that said assembly (401) is composed of an upper (412) and of a breathable or perforated insole (413), which is joined to the edges of said upper (412) by means of stitches (402) according to the structure known as "strobel" or "ideal welt", so as to form a pouch, said waterproof membrane (421) adhering to said breathable or perforated insole (413), said assembly (401) comprising, along the perimeter of said waterproof membrane (421), a sealing area (421a) that straddles said stitched seams (402) and said waterproof membrane (421).

25 29. The shoe according to claim 27, characterized in that said assembly (501) is composed of an upper (512) that is coupled externally to said sole (500) by means of its lower edges (512a) and internally to a waterproof membrane (521) that forms a pouch for containing foot

insertion.

30. The shoe according to one of the preceding claims, characterized in that said microporous upper layer (15, 215, 315, 415, 515) that is permeable to water vapor is made of leather.